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SUPPORT LOAD REQUIREMENTS FOR MAINTAINING SALVAGED FACELINES

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SUPPORT LOAD REQUIREMENTS FOR MAINTAINING SALVAGED FACELINES

by

P. Cain*

ABSTRACT

This report describes the methods of support used during the stripping of longwall coalfaces at Lingan Colliery of the Cape Breton Development Corporation. By applying accepted strata control theory, a possible inadequacy of the support system is demonstrated.

Results of an investigation to try to determine the support load on present support systems are described and discussed, and recommendations for improving the support design given.

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EXIGENCES RELATIVES À LA CHARGE DE SOUTÈNEMENT POUR MAINTENIR LES FRONTS DE TAILLE RÉCUPÉRÉS

par

P. Cain*

RÉSUMÉ

Le présent rapport décrit les méthodes de soutènement utilisées au cours de l'extraction des fronts de longue taille à la mine Lingan de la Société de développement du Cap-Breton. L'application de la théorie acceptée du contrôle des strates permet de démontrer que le système de soutènement peut être inadéquat.

Dans ce rapport, on décrit et examine les résultats d'une étude en vue de déterminer la charge que supportent les systèmes de soutènement actuels, et on fait des recommandations afin d'améliorer la conception de ces derniers.

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INTRODUCTION

The removal of faceline powered supports and associated equipment from an exhausted advancing longwall panel at Lingan Colliery in Nova Scotia requires the provision of ventilation to the workplace by maintaining the face opening after the hydraulic supports have been withdrawn. Failure to maintain sufficient ventilation, for example in the event of a roof fall obstructing the air path, would necessitate expensive and inefficient auxiliary ventilation installations and a protracted delay in face stripping activities.

In addition to the requirement to ventilate the faceline during the stripping operations, the abandoned face opening must be maintained as part of the return air route in the cundy system of ventilation used on the very long advancing longwalls at Lingan Colliery (Figure 1).

In order to determine the support required to maintain the face opening, it is necessary to consider the strata mechanical environment of the face opening at the cessation of coal mining operations.

STRATA MECHANICAL ENVIRONMENT

The strata mechanical environment around a longwall coalface has been described in terms of a detached roof block (Figure 2) (1). Support loading on a longwall coalface can thus be calculated for the worst case, i.e. total separation of the block, by considering the mass of the detached block.

This theory would also apply to a face opening in the process of being stripped, except that several other factors would also contribute to the total support load, for example:

1) the effect of the reduction of the rate of face advance as preparations for stripping operations were made, and
2) the time dependent convergence of the face opening due to the convergence of the bridging beds as the final subsidence profile develops.

In the absence of information on these effects, the detached roof block concept must be applied without modification.

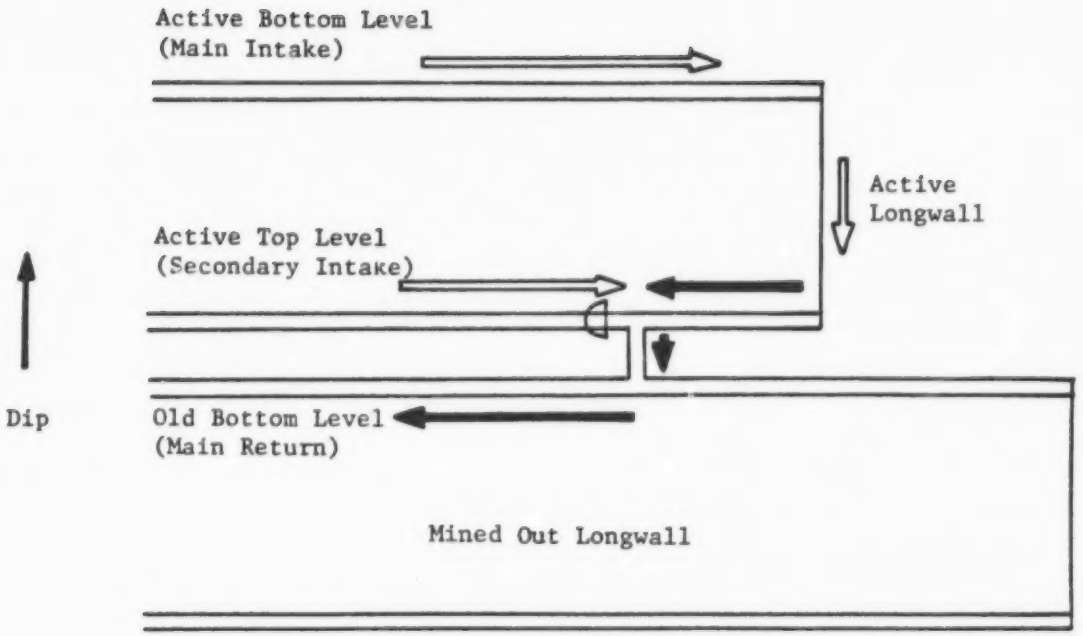


Figure 1 - 'Cundy ventilation' as practised at Lingan Colliery

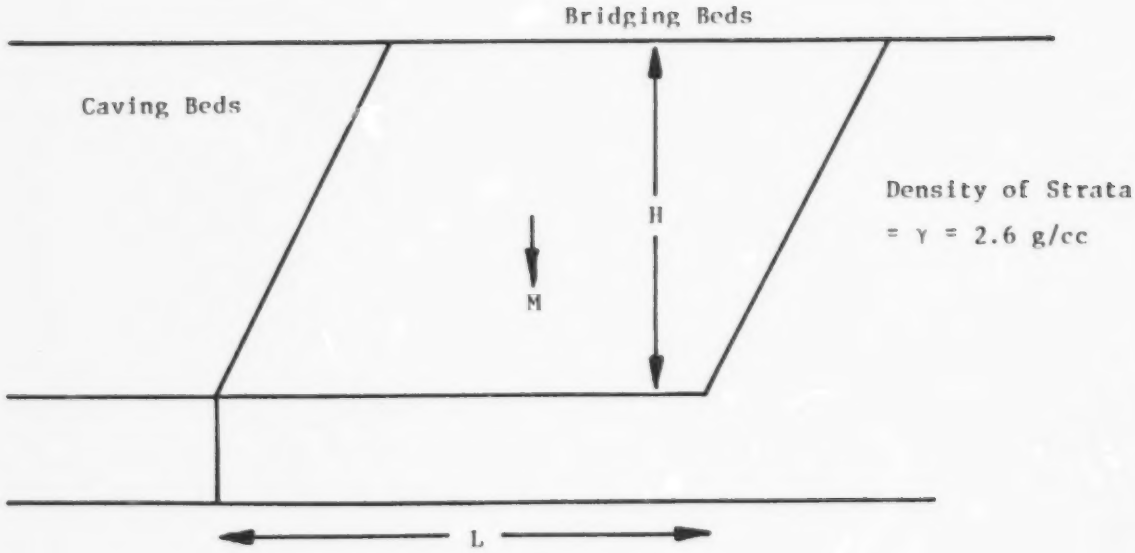


Figure 2 - Detached roof block hypothesis of faceline support loading

Although the detached block analysis is adequate for faceline supports under normal conditions, it must be remembered that faceline support is only temporary. To maintain a faceline opening for an extended period may well require the provision of support resistances approaching those required for gateroads.

CURRENT SUPPORT METHODS

The method of support utilized by CBDC on longwall coalfaces prior to stripping consists of the following:

1) prior to the faceline stop, roof bolts, wire mesh and sometimes wire ropes strung above the chock canopies and anchored at each end of the faceline are installed over the last few cuts, ensuring that the mesh extends from finished faceline to the gob,
2) as the powered supports are withdrawn, two 0.75 x 0.75 m hardwood chocks are installed on 1.50 m centres, one at the gobline and one between the gobline and the face, and
3) as required, (usually every 15 m), 0.75 x 0.75 m hardwood chocks are constructed at the face.

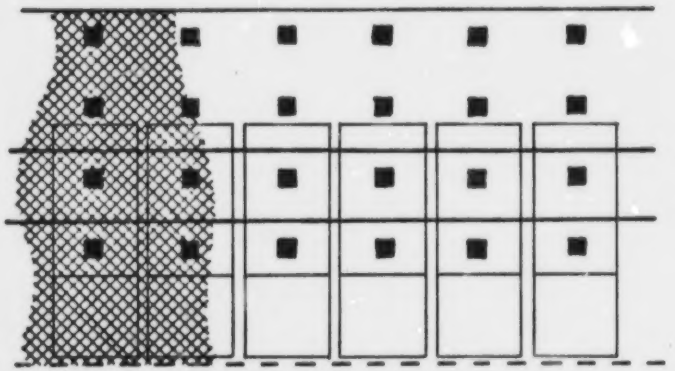
As the powered supports are removed, a trailing shield is used to protect the immediate work area. The support methods are shown in Figure 3.

Effective permanent support is only offered by the hardwood chocks. The roof bolts, mesh and wire rope act only as supplementary support preventing the deterioration of the roof beam. The load bearing capacity of the hardwood chocks is therefore all that is considered in this analysis.

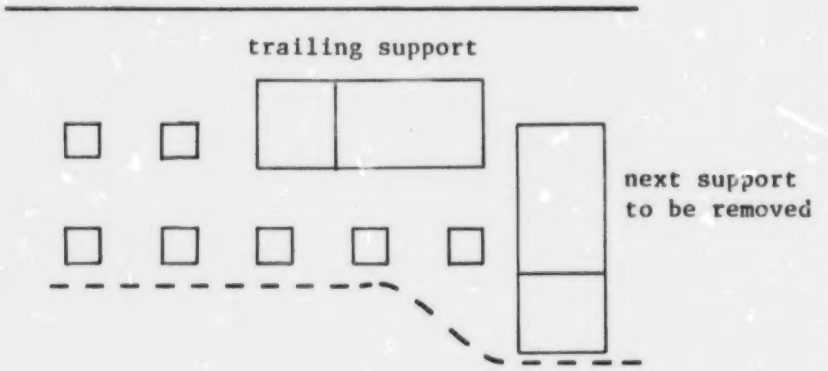
ANALYSIS OF SUPPORT REQUIREMENT

Using the concepts and formulae illustrated in Figure 2, the mass of the roof block, M, supported by each powered support on the longwall being stripped is given by:

$$M = H.W.L.9.81 \qquad \text{Eq. 1}$$



a) Roof bolts, mesh and cables installed over last few cuts.



b) Wooden chocks built to support roof as shields removed

Figure 3 - Current support methods during faceline stripping

H = caving height = 5.71 m
W = support centres = 1.5 m
L = cave line to face distance = 6.1 m
γ = strata density = 2600 kg/m^3

therefore, $M = 1.33 \times 10^6$ N

The support resistance required, R, can be derived thus,

$$R = M/A \qquad \text{Eq 2}$$

where A is the area of influence of each support. In the case under consideration,

$$A = 1.5 \text{ m} \times 6.1 \text{ m}$$
$$A = 9.272 \text{ m}^2$$

substituting for A and M in equation 2,

$$R = 1.33 \text{ MN}/9.272 \text{ m}^2$$
$$R = 0.144 \text{ MN/m}^2$$

In the calculation of support load requirements for conventional longwall powered support faces, a safety factor of 2 is usually assumed. On coalfaces at Lingan Colliery, the safety factor is approximately 3.5. Thus, the support resistance required to maintain the longwall face opening for stripping is between 0.288 MN/m^2 and 0.504 MN/m^2.

SURVEY OF 6E FACELINE

In order to determine the support resistance on a resupported faceline, an investigation was carried out on the 6E, after approximately half of the powered supports had been removed.

The powered supports are withdrawn in sequence from the coalroad end and hauled up the wallface to the tailgate, where they are loaded on

special rail cars and taken out of the pit. The faceline on 6E was resupported as described above, except that no wire ropes were used. During the stripping operation, strain on every tenth wood chock pair set on the faceline was determined in the following manner:

1) The original height of the chock was estimated by counting the number of layers in each chock.
2) The height of each chock at the time of the survey was determined by measuring the width of five chock pieces at the loading points. An average of seven readings from each chock was used. This method was chosen as in many instances the base of the chock was hidden by debris.
3) Strain was then calculated in the usual way.

Since no direct loads could be determined in the chocks, chock loads were determined from the load deformation characteristics of a similar chock tested under laboratory conditions. Work done by Zorychta et al. (2) resulted in the definition of stress/strain characteristics for a hardwood chock similar to those investigated (Figure 4). Thus, the load on each chock could be determined indirectly.

RESULTS

The results obtained from the investigation are shown in Table 1. The faceside and gobside chock stresses were inferred from the strain data as described above. The resistance value is the sum of the stresses divided by the area of influence of each chock pair. The support resistance and chock stresses on the resupported faceline are shown isometrically in Figure 5.

DISCUSSION

The results given show that the support resistance attained on the 6E faceline after stripping was dependent on the location with respect to the gateroad and the time since the secondary support was installed. Resistances increase from Stations 9 to 7 inclusive, after which a level of 0.447 MPa (average of Stations 2 to 6) is maintained until Station 1, where the

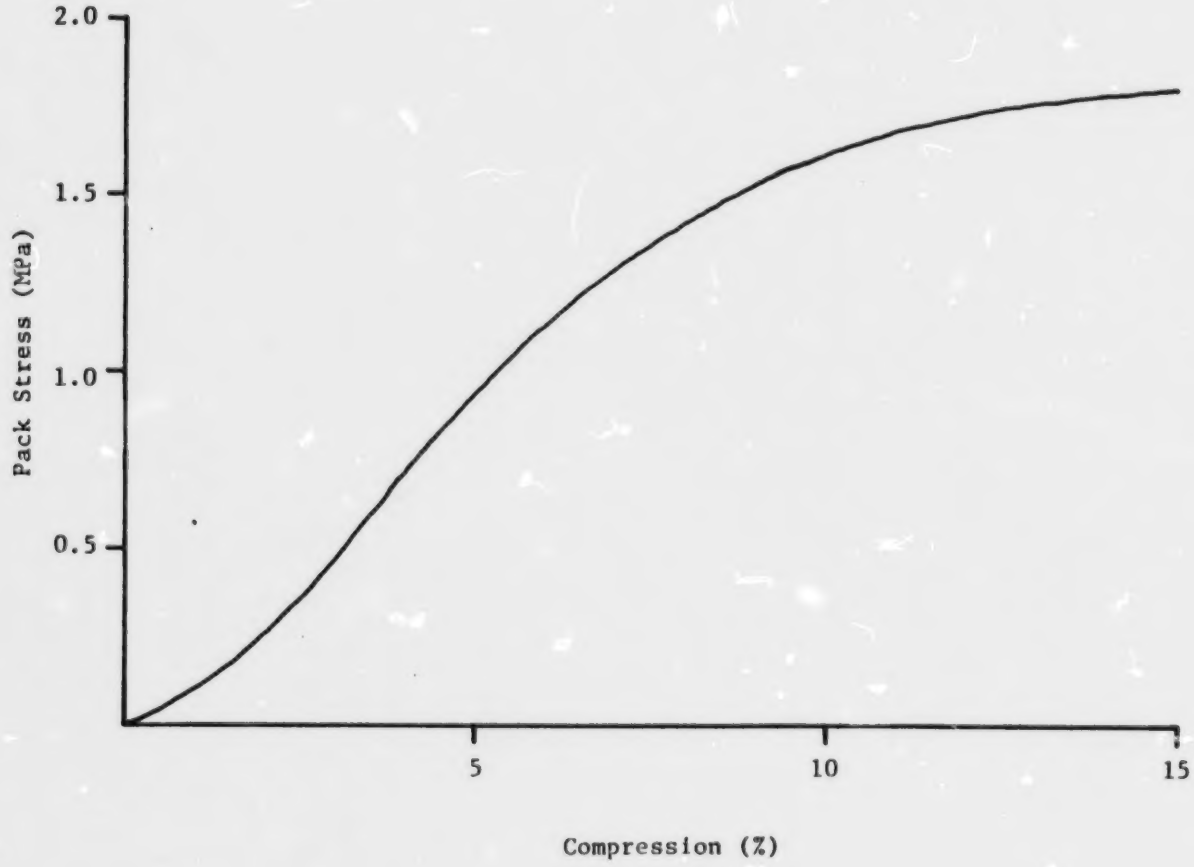


Figure 4 - Stress/strain curve for a wooden chock (after Zorychta and et al.)

Table 1 - Summary of results

		Face Side Chock				Gob Side Chock					
Station	Distance From Tailgate (m)	Original Height (m)	Measured Height (m)	Strain %	Inferred Stress MPa	Original Height (m)	Measured Height (m)	Strain %	Inferred Stress MPa	Area of Influence m^2	Resistance MPa
1	0	2.017	1.947	3.4	.78	2.172	2.041	6.0	1.19	6.39	.308
2	15	2.327	2.209	5.0	1.07	2.172	1.838	15.3	1.80	6.39	.449
3	30	2.172	1.976	9.0	1.55	2.017	1.731	14.1	1.76	7.30	.453
4	45	2.172	2.023	6.8	1.27	1.861	1.590	14.5	1.7	6.63	.447
5	60	2.172	2.032	6.4	1.24	1.706	1.562	8.4	1.50	6.63	.413
6	75	2.172	1.988	8.4	1.48	1.861	1.617	9.6	1.56	6.39	.475
7	90	1.706	1.667	2.2	0.49	1.861	1.682	9.6	1.56	6.85	.299
8	105	2.017	2.017	0	0	1.861	1.734	6.8	1.3	7.54	.172
9	120	1.861	1.831	1.5	0.17	2.172	2.095	3.5	0.81	6.85	.143

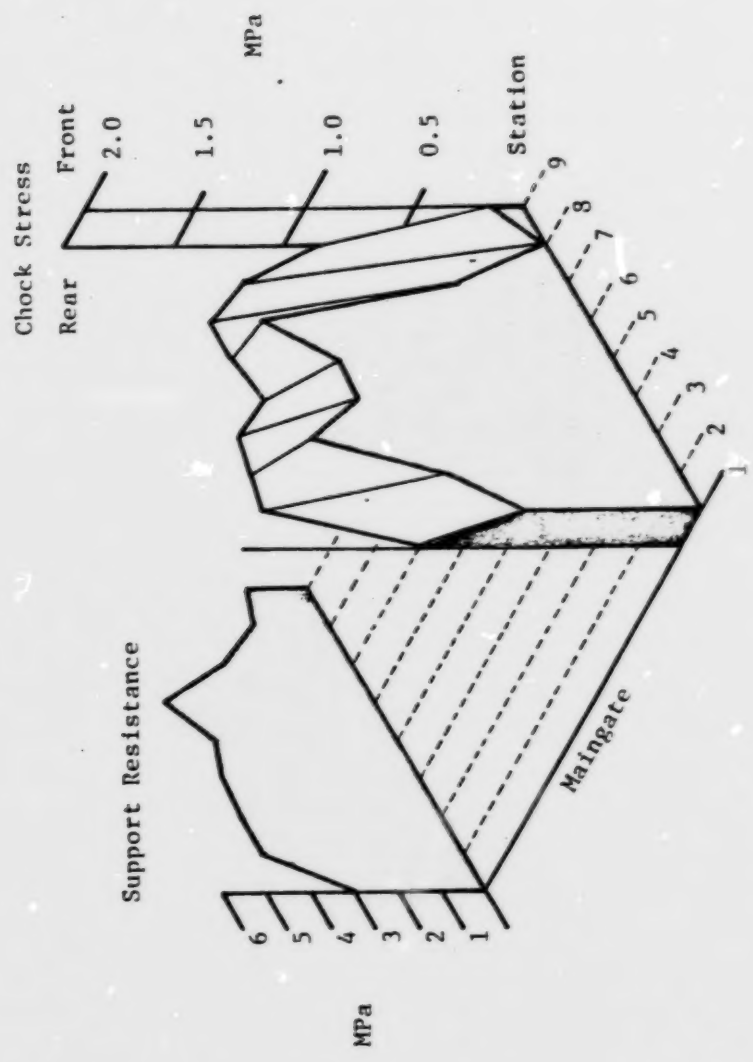


Figure 5 - Representation of chock stress and support resistance 6E Faceline

resistance drops slightly. The initial rising resistance is due to the closure of the faceline after the powered supports are removed and before the chocks have developed any resistance to the closure. The tailing off of the resistance at the gateroad and (Station 1) is probably due to the protection given to the face end by the solid coal around the face/gateroad junction.

Considering a detached roof block forming over the faceline, extending to four times the seam height above the roof of the seam results in the derivation of a required support resistance of 0.21 MPa if a strata density of 2600 kg/m^3 is used. In the U.K., faceline supports have been dimensioned using this method and a safety factor of 2. The yield load density of the powered supports on the 6E faceline amounted to 0.59 MPa. The resistances offered along the resupported faceline exceed the calculated required resistance (S.F = 1) but are 24% less than the faceline resistance. Experience with long shutdowns (3 month strike in 1982) has shown that this yield load density is sufficient to maintain adequate conditions on the faceline for several months.

Subsequent to this investigation, a roof fall occurred on the 6E faceline. This may have been due to other factors, such as roof guttering due to locally ineffective bolting/meshing or originally poor roof conditions due to geological variation. Its occurrence, however, does indicate that the method of roof support currently practised gives rise to concern over its ability to control closure in the resupported faceline over extended periods.

CONCLUSIONS

Back analysis of loads generated on support elements in a resupported longwall face opening maintained for stripping and ventilation may not be sufficient to maintain the stability of the opening. The calculation was based on measurements of strain on the support elements and analytical loading theories. Whilst this method has many inherent inaccuracies, the occurrence of a roof fall on the faceline investigated suggests that the method of resupport warrants further investigation.

RECOMMENDATIONS

It is recommended that further observation and possibly monitoring of loads on support elements in facelines being stripped be conducted to determine the stability of the openings utilising this method of support.

Current stripping operations on 5W panel at Lingan Colliery provides ideal instrumentation opportunities, whilst other airways, such as 7E and 4W panels allow for additional back analysis.

ACKNOWLEDGEMENTS

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